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THIS IS UNEVALUATED INFORMATION FOR THE RESEARCH USE OF TRAINED INTELLIGENCE ANALYSTS

SOURCE DOCUMENTARY

On file in the CIA Library is a reprint from Nature, Volume 160, page 614, dated 1 November 1947, of the article "Valve with Trochoidal Electronic Motion" by Prof H Alfven and H Romanus. Prof Alfven, one of the authors of this paper, is understood to have developed the Trochotron Tube.

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(*Reprinted from* NATURE, *Vol.* 160, *page* 614, *November* 1, 1947.)

VALVE WITH TROCHOIDAL ELECTRONIC MOTION

By PROF. H. ALFVÉN and H. ROMANUS
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IN a homogeneous magnetic field an electron with a velocity perpendicular to the field moves in a circle. If an electric field is applied perpendicularly to the magnetic field, the circle 'drifts' with a velocity which to a first approximation (electric field not too strong) is

$$\mathbf{v} = -\frac{c}{H^2}\mathbf{H} \times \mathbf{E}.$$

The combined motion is a cycloid or trochoid. As the drift is perpendicular to the electric field, the circle in which the electron moves is displaced along *an equipotential line*.

If a beam of electrons moving in cycloids or trochoids is produced, this beam follows that equipotential line on which it started. As in a valve an equipotential line is easily changed and can be given almost any desired shape, a trochoidal beam possesses a high flexibility and can be used for many technical purposes, for example, the construction of electronic switches and counters.

During recent years research on valves with cycloidal or trochoidal electronic motion has been carried out at this laboratory. The development of the valves, which are called 'trochotrons', has been carried out by G. Hambraeus and, especially, T. Wallmark. Different circuits for the valves have been

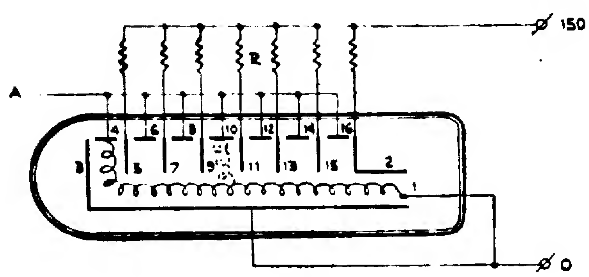

Fig. 1

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worked out by Lindberg, Lundquist, Warring and Åström.

The type of valve mostly used at present is shown diagrammatically in Fig. 1.

A homogeneous magnetic field (100–200 gauss) is applied perpendicular to the plane of the paper. The filament 1 emits electrons which are attracted by the anode 2. Due to the magnetic field, however, they never reach the anode. Instead, a trochoidal beam is formed travelling along an equipotential line of the electric field formed between the electrode 3, which is held at zero or negative potential, and the electrodes 4–15, normally given positive potentials of 100–200 volts. The whole current emitted (about 1 mA.) is thereby received by the 'plate' 4.

If the potential of one of the electrodes 5, 7, 9, 11, or 13 (the 'guides'), for example, that of 9 is decreased to about 20 volts or lower, the equipotential line followed by the beam enters the box between 9 and 11. The current goes to plate 10, and in part also to guide 9. If this is connected to the voltage supply through a resistance R, the voltage drop in R will maintain the low potential on the guide. Consequently, if once *the beam is brought into a certain box it remains locked up there.* In other words, the electron beam of the valve has the peculiar quality that it is attracted to an electrode having a certain voltage, but diverted from the same when the voltage is decreased or *increased*. This implies a negative slope in one part of the voltage-current characteristic of all the electrodes in the valve, that is, every electrode may under certain voltage conditions act as a negative resistance. The characteristic of an electrode is shown in Fig. 2, where AB represents a series resistance, giving the locking position C.

The great flexibility of the trochoidal electron beam also makes it possible to use 'two-dimensional' electrode systems as in Fig. 3. If all electrodes except 0 are held at a high positive potential, the current

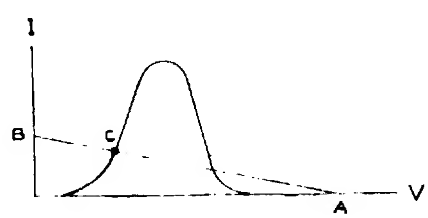

Fig. 2

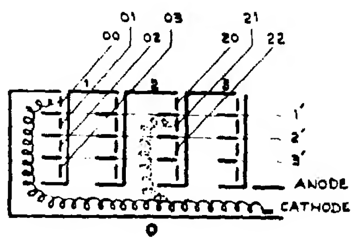

Fig. 3

goes to the plate 00. It may be switched, for example, to the plate 21 by putting the vertical guide 2 and the set of horizontal guides 1′ under zero voltage.

A 10-box valve (see Fig. 1) is preferably used as an electrical counter ('scale-of-ten'). The pulses to be counted should be negative. They are applied to A, which is normally held at about 100 volts. Suppose that the beam at the beginning is landing on plate 4 in the first box. A decrease of the potential of this plate will displace the beam towards guide 5. Due to the resistance R in series with this electrode, the potential of 5 will immediately drop, so that the beam is brought into the second box. The next pulse will displace the beam from plate 6 to guide 7, which through a potential drop transfers the beam to the third box and so on. Finally, on arriving at guide 15, the beam is transferred to anode 2, and the anode potential will drop in the same way due to a series resistance, with the result that the emission from the cathode is cut off for a moment. Hence the initial conditions are restored so that the beam again goes to plate 4. Thus the valve may be operated as a cyclic switch. From the anode or one of the guides, every tenth of the input pulses may be tapped to another scale-of-ten unit or to a mechanical counter. Neon lamps in series with the plates may be used to indicate the actual position of the beam.

In this way the trochotron is used in electric counters and chronoscopes. It seems also to be a useful unit in calculating machines. A system for pulse-time modulated multiplex telephony has also been worked out, in which the valve is used as a cyclic switch and modulator or demodulator simultaneously.

Detailed reports of the investigations are in preparation.

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